A SMOKE ELIMINATOR

By W. D. SHEETS, Ch.E. 4

From time to time many suggestions for eliminating smoke have been offered. Among these has been that the smoke be eliminated before using the coal. Incredible as this may seem, an account of the By-Product Coke Plant will indicate how it may be accomplished. While a plant requires a large outlay of money for construction, yet anyone living in a smoky community will think it worth many millions of dollars. In addition to the smoke eliminating process, the by-products plant, as the name indicates, has made for many developments that affect our everyday life.

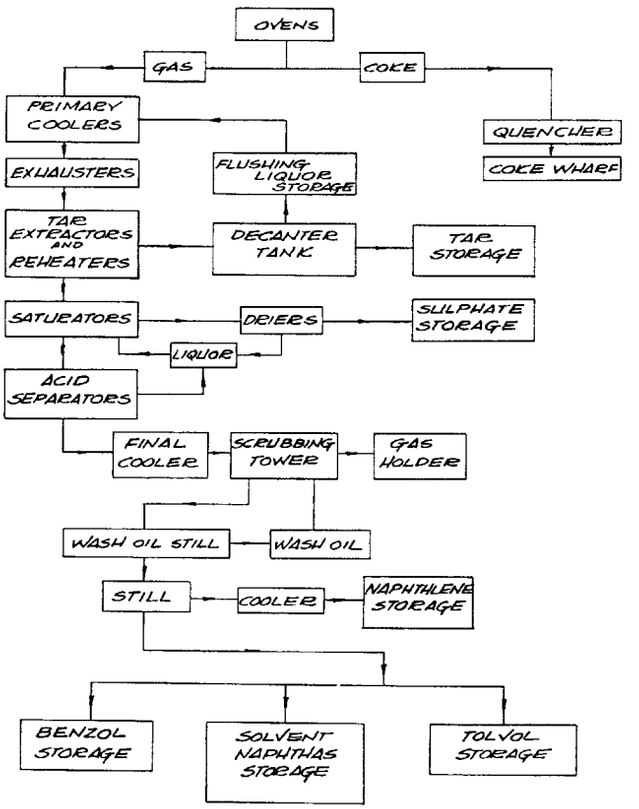
For a description of the process a model might be chosen and in this case the plant of the Carnegie Steel Company, located at Clairton, Pa., has been picked. Now see what will become of the smoke which ruins our shirt collars and makes the best girl-friend's complexion look like the favorite spotted tie! This plant happens to be at presented the largest in the world and when working a twenty-four hour day, nineteen hour schedule, will turn out enormous quantities of products. The quantities as given later are all approximate and are for the schedule stated which means that each oven is loaded, burned, and discharged in nineteen hours.

There are three main divisions in the plant, each taking in different parts of the process, namely, the ovens, the by-product plant, and the benzol plant.

First there are 1482 ovens arranged in batteries of 64 ovens each, all being of the "Koppers 500" (cu. ft.) or of 13.3 tons capacity. They require 25,000 tons of coal which is loaded in at the top of the oven by means of a larry or hopper on wheels; this serves one battery. Then there is a large "pusher" which runs along one side and levels out the coal in the oven. The ovens are equipped with removable doors at either end and are packed with fire-clay while the oven is burning. The coke is discharged into a car drawn by a locomotive and is rapidly carried to a quencher. After the coke is cooled it is dumped in a coke wharf and is classified according to size, porosity, and quality. The products at this point consist of 16,700 tons of furnace coke, 500 tons of domestic coke, and 1,500 tons of breeze and coke dust.

The breeze and coke dust are not marketable and are used in this plant to generate what steam is needed for pumps and engines. Attempts have been made to form small briquets by binding it together with pitch, but the process is too expensive to compare with cheaper fuels.

The gas is drawn off through a suction main from 36″ to 60″ in diameter, under a slight vacuum of about 2 mm. of water, and passes through the primary coolers which cool it to about 125 degrees C. This cooling causes some of the tar vapors to condense and collect in the coolers and mains. Some ammonia is also absorbed by this tar and small amounts of water in the system. This liquid then becomes known as weak ammonia liquor and upon being heated gives up the



Flow Sheet of By-Product Coke Process

ammonia as free ammonia. Proper stills are provided and the ammonia is recovered, either to be piped into the gas main just previous to its entrance into the by-product plant or to be compressed and sold as free ammonia.

The gas passes to the exhausters which have caused the slight vacuum so far in the system. Upon being discharged on the other side of the exhausters the gas has been compressed and is now under a slight pressure. This pressure is utilized in the next step where the remaining tar in the gas is removed. The apparatus is called the tar extractor and uses a steel plate containing a large number of small holes, through which the gas passes with increased velocity and impinges on a second steel plate causing all entrained tar to be deposited. The whole of the system through which the gas has so far passed is continuously flushed with a light tar and weak ammonia liquor. The liquor runs into large decanter tanks where the heavier tar settles to the bottom and is drawn off and stored. The yield of tar is 285,000 pounds. The liquor remaining on top consisting of light tar oil and weak ammonia liquor is decanted from the tank and is again used in flushing the system. It requires about 450 gallons of flushing liquor per ton of coal burned to keep the system clear of tar.

The gas next passes through reheaters and is brought to 120°C., at which temperature the best results are obtained, and is bubbled through a weak 5% solution of sulphuric acid in the satura-

(Continued on Page 18)

A SMOKE ELIMINATOR

(Continued from Page 7)

tors. This removes all of the ammonia left in the gas as ammonium sulphate, in which form it is removed from the saturators by air injectors and is dried in centrifugal driers. The sulphate, 65,000 pounds of which is obtained, is then dumped on a conveyor and stored or bagged. It is shipped either in bulk or in bags and is very valuable as a fertilizer. Research has determined the fact that the sulphate is an ideal one due to the fact that under the conditions of application it gives up the ammonia slowly and thus does not cause a strong application over a short period, thus injuring the crops.

The gas may have picked up some moisture in the saturator and so it next enters the acid separators where the entrained moisture is removed.

The gas leaves the by-product building going to a series of towers in the first of which it is passed through a final cooling step by means of a counter flow of water and gas. The next towers are called the scrubbing or debenzolizing towers. The counterflow principle is again used and the gas passes through a spray of a light wash oil which removes all the remaining free constituents and leaves 275,000,000 cubic feet of fixed gases of 565 B.T.U. average thermal value to pass to the gas holders. The loss in heat value of this gas from removal of the by-products from a given amount of coal amounts to about 5 to 6%.

The wash oil is drawn from the scrubbing towers and enters the benzol plant where it is distilled in a still using a simple fractionating column. This operation is intermittent and is carried on until all but the original wash oil has

(Continued on Page 20)

A SMOKE ELIMINATOR

(Continued from Page 18)

been driven off. This is run out and a new charge enters, the oil just removed being piped back to the towers.

From the distilled liquid the naphthalene is crystallized out by cooling the condensed liquid to the proper point and is removed. This gives us 10,000 pounds of prospective "moth-balls." It is extremely important that all of the naphthalene is removed from the gas as it easily crystallizes out in the lines and soon clogs them up.

The remaining liquid is then passed to more stills and is separated into the simpler divisions. The final products from these stills are 68,000 gallons of motor benzol or 50,000 gallons of C.P. benzol, 11,500 gallons of C.P. toluol, and 10,500 gallons of refined solvent naphthas.

The products are then stored and sold direct to the manufacturers who carry on all the further separations and adaptations to something else. Here is where the smoke explodes into a million parts! Ask any organic chemist; at the last count the products totaled about 100,000 and the number is still growing. They range from fountain pens, drugs, dyes, and synthetic food products to road building materials.

In an address by Charles J. Ramsburg, vice president of the Koppers Co., in response to the Westinghouse Salute to the By-Product Coke Industry radiocast on August 5, 1930, Mr. Ramsburg said, "Coal products are used in automobiles, aeroplanes, radios, moving pictures, electrical equipment; in fact, in practically every major industry. They will supply anti-knock quality to your gasoline, propel your automobile, develop your photographs, help decorate your home, flavor your food, and will bring you the luxury of the rarest perfumes . . . " and last, but not least, household coke, which bids fair to become the most important fuel in leading us from smoky skies and soot-laden atmosphere to sunshine and health.